Deutsches Institut für Bautechnik

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Bautechnisches Prüfamt

An institution established by the Federal and Laender Governments

Designated according to Article 29 of Regulation (EU) No 305/2011 and member of EOTA (European Organisation for Technical Assessment)

European Technical Assessment ETA-08/0038 of 27 September 2018

English translation prepared by DIBt - Original version in German language

General Part

Technical Assessment Body issuing the European Technical Assessment:	Deutsches Institut für Bautechnik
Trade name of the construction product	BESISTA 2-540 Tension Rod System
Product family to which the construction product belongs	Prefabricated Tension Rod System
Manufacturer	BESISTA International GmbH Heckenweg 1 73087 Bad Boll DEUTSCHLAND
Manufacturing plant	BESISTA International GmbH Reuteweg 3 73087 Bad Boll DEUTSCHLAND
This European Technical Assessment contains	16 pages including 11 annexes which form an integral part of this assessment
This European Technical Assessment is issued in accordance with Regulation (EU) No 305/2011, on the basis of	EAD 200032-00-0602

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Specific Part

1 Technical description of the product

The construction product is a prefabricated tension rod system of different system sizes used as a kit. The tension rod system consists of steel (tension rods) with external threads which are connected to each other and to the corresponding structure by special connecting devices. The tension rods are connected to the corresponding structure by spheroidal graphite cast iron fork end connectors with two eye loops and internal thread. The fork end connectors are connected by double shear pin connections to corresponding steel gusset plates, cross plates or circular discs. The tension rods are connected to each other by steel threaded sleeves (coupler, turnbuckle).

The tension rod system comprises tension rods, rod anchors, cross anchors, anchor discs, cross plates and threaded sleeves (coupler, turnbuckle) with metric ISO threads M 6 to M 76.

Drawings of the tension rod system and the components as well as the essential dimensions of the components are given in the Annexes to this European Technical Assessment.

2 Specification of the intended use in accordance with the applicable European Assessment Document

The tension rod system is intended for the use in structures with static or quasi-static loads according to EN 1990:2002, where no verification of fatigue relating to EN 1993-1-9:2005 is necessary.

The intended use comprises for instance the suspension of roof structures or vertical glazings as well as bracings and truss structures. The tension rod system is not subjected to systematic bending. The fork end connectors may also be connected to compression bars. The compression bars themselves with a strength class not higher than strength class S355 are not part of the European Technical Assessment.

The performances given in Section 3 are only valid if the tension rod system is used in compliance with the specifications and conditions given in Annex A and Annexes B1 to B9.

The verifications and assessment methods on which this European Technical Assessment is based lead to the assumption of a working life of the tension rod system of at least 25 years. The indications given on the working life cannot be interpreted as a guarantee given by the producer, but are to be regarded only as a means for choosing the right products in relation to the expected economically reasonable working life of the works.

3 Performance of the product and references to the methods used for its assessment

3.1 Mechanical resistance and stability (BWR 1)

3.1.1 General

The dimensions, tolerances and materials of the components of the tension rod system not indicated in Annexes shall correspond to the respective values and information laid down in the technical documentation[1] to this European technical assessment.

3.1.2 Rod anchors, cross anchors, gusset plates, cross plates, anchor discs and threaded sleeve (coupler, turnbuckle), pins

Essential characteristic	Performance
Geometry incl. tolerances	See Annexes B3 to B9
Dimensions incl. tolerances	
Thread incl. tolerances	
Material	See Annex B2
Load bearing capacity	See Annex A
Resistance to corrosion	

3.1.3 Tension rod

Essential characteristic	Performance
Nominal rod diameter	See Annexes B3 to B9
Thread incl. tolerances	
Yield strength	See Annex B2
Tensile strength	
Material	
Tension resistance	See Annex A
Compression force	
Resistance to corrosion	

3.2 Safety in case of fire (BWR 2)

Tension rods, rod anchors, gusset plates, cross anchors, cross plates, anchor discs and threaded sleeve (coupler, turnbuckle), pins

Essential characteristic	Performance
Reaction to fire	Class A1 according to EN 13501-1:2007+A1:2009

The components of the tension rod system satisfy the requirements for performance class A1 of the characteristic reaction to fire, in accordance with the provisions of EC decision 96/603/EC (as amended).

3.3 Safety and accessibility in use (BWR 4)

See BWR 1.

[1] The technical documentation to this European Technical Assessment is deposited with Deutsches Institut für Bautechnik and, as far as relevant for the tasks of the approval bodies involved in the attestation of conformity procedure is handed over to the approved bodies.

4 Assessment and verification of constancy of performance (AVCP) system applied, with reference to its legal base

In accordance with European Assessment Document EAD No. 200032-00-0602, the applicable European legal act is: 98/214/EC.

The system to be applied is: 2+

5 Technical details necessary for the implementation of the AVCP system, as provided for in the applicable EAD

Technical details necessary for the implementation of the AVCP system are laid down in the control plan deposited with Deutsches Institut für Bautechnik.

Issued in Berlin on 27 September 2018 by Deutsches Institut für Bautechnik

Dr.-Ing. Lars Eckfeldt
p. p. Head of Department

beglaubigt:
Bertram

Annex A

A.1 Assumptions concerning design

The design of the tension rod system is carried out under the following conditions:

The loading is static or quasi-static according to EN 1990:2002 without need of verification of fatigue relating to EN 1993-1-9:2005.

The tension rod system is not used, when constructions are susceptible to vibrations under wind loads or wind-induced cross vibrations of the entire construction appear.[2]

Dimensions, material properties and screw-in lengths "MeT" and "GL" given in Annexes B2 to B9 are observed.

The tension rod system is not subjected to systematic bending.

The verification concept stated in EN 1990:2002 as well as the design values of resistance stated below are used for design.

The rules given in EN 1090-2:2008 and EN ISO 12944:1998 are taken into account.

Design is carried out by the designer of the structure experienced in the field of steel structures.

Design tension resistance of the tension rod system:

The design value $F_{t,Rd}$ of the tension resistance of the entire tension rod system (tension rods, rod anchors incl. pins, cross anchors, couplers, turnbuckles, cross plates or anchor discs and gusset plates) is the minimum value of the design tension resistance of the tension rod ($F_{t,Rd,Tension\ Rod}$), the turnbuckle ($F_{t,Rd,Turnbuckle}$) and the coupler ($F_{t,Rd,Coupler}$) and the design bearing resistance of the gusset plate, cross plate and anchor disc ($F_{b,Rd,Gusset\ Plate,Cross\ Plate,Anchor\ Disc}$).

The design values shall be determined according to EN 1993-1-1:2005 and EN 1993-1-8:2005 as follows:

$$F_{t,Rd,Tension\ Rod} = \min \{A \cdot f_{y,k}/\gamma_{M0};\ 0{,}9 \cdot A_S \cdot f_{u,k}/\gamma_{M2}\}$$

A	=	minimum cross section of the unthreaded part of the tension rod
A_S	=	cross section of stress area of the threaded part of the tension rod
$f_{y,k}$	=	characteristic value of the yield strength of the tension rod material according to Re / $R_{p\,0,2}$ given in Annex B2
$f_{u,k}$	=	characteristic value of the tensile strength of the tension rod material according to R_m given in Annex B2

$$F_{t,Rd,Turnbuckle} = A \cdot f_{y,k}/\gamma_{M0}$$

A	=	net cross section of the unthreaded part of the turnbuckle
$f_{y,k}$	=	characteristic value of the yield strength of the turnbuckle according to the minimum value of R_e and $R_{p0,2}$ respectively given in Annex 2

$$F_{t,Rd,Coupler} = A_S \cdot f_{u,k}/\gamma_{M2}$$

A_S	=	cross section of stress area of the threaded part of the coupler
$f_{u,k}$	=	characteristic value of the tensile strength of the coupler according to the minimum value of R_m given in Annex 2

[2] The national provisions of the Member State applicable for the location where the product is incorporated in the works shall be taken into account.

$$F_{b,Rd,Gusset\ Plate,Cross\ Plate,Anchor\ Disc} = 1{,}5 \cdot w_2 \cdot d_1 \cdot f_{y,k}/\gamma_{M0}$$

w_2 = thickness of gusset plate, anchor disk and cross plate according to Annexes B3, B5 and B9

d_1 = pin diameter according to Annexes B3 and B7

$f_{y,k}$ = characteristic value of the yield strength of the gusset plate, cross plate and anchor disc material according to Re / $R_{p\ 0,2}$ given in Annex B2

γ_{M0} = 1,00 for steel

γ_{M2} = 1,25

The values given for the partial safety factors γ_{M0} and γ_{M2} are recommended minimum values. They should be used in cases where no values are given in national regulations of the Member State where the tension rod system is used or in the respective National Annex to Eurocode 3.

Screw-in depths "MeT" and "GL" given in Annexes have to be observed.

Design values of the compression force of the rod anchor

The design compression resistance of the rod anchor used for the connection to compression bars is at least equal to the tension resistance $F_{t,Rd,Tension\ Rod}$ of the tension Rods.

A.2 Assumptions concerning Installation

The installation of the tension rod system is carried out under the following conditions:

The installation is only carried out according to the manufacturer's instructions. The manufacturer hands over the assembly instructions to the assembler. From the assembly instructions it is followed that, prior to installation, all components of the tension rod system shall be checked for their perfect condition and that damaged components shall not be used.

The rod anchors are not subjected to sudden or impact loads (for instance pins of fork end connectors may not be adjusted by hammer blows).

The minimum screw-in lengths are marked in an appropriate way. The keeping of the minimum screw-in lengths "MeT" and "GL" given in Annexes is checked by the assembler. How to do this is described in the assembly instructions. The compliance of the screw-in lengths shall be attested with a written confirmation by a person responsible for the construction site.

All relevant components shall be checked continuously regarding corrosion damage after installation. The result of the checks should be recorded.

The conformity of the installed tension rod system with the provisions of the European Technical Assessment is attested by the executing assembler.

A.3 Indications to the manufacturer

The manufacturer shall ensure that the information on the specific conditions is given to those who are concerned. This information may be given by reproduction of the European Technical Assessment. In addition all essential installation data (e.g, minimum screw-in length "MeT" and "GL" according to Annexes) shall be shown clearly on the package and/or on an enclosed instruction sheet, preferably using illustration(s).

The prefabricated tension rod system shall be packaged and delivered as a complete unit only (tension rods, rod anchors incl. pins, cross anchors, gusset plates, cross plates, anchor discs, coupler and turnbuckles).

The fork end connectors used for the connection to compression bars may also be delivered separately.

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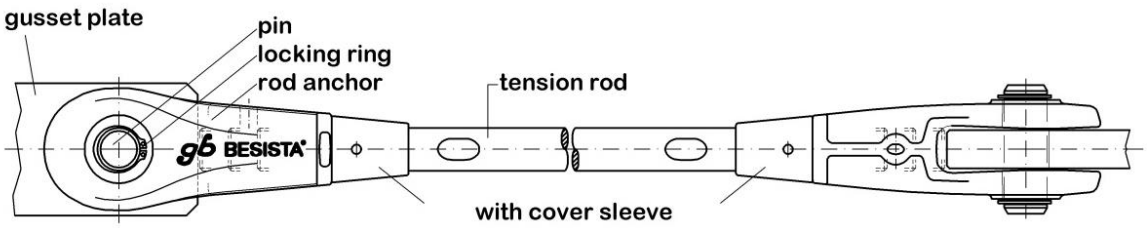
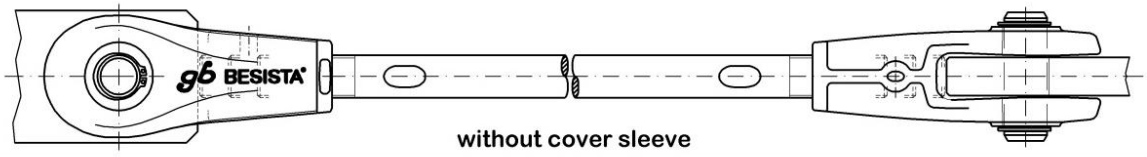
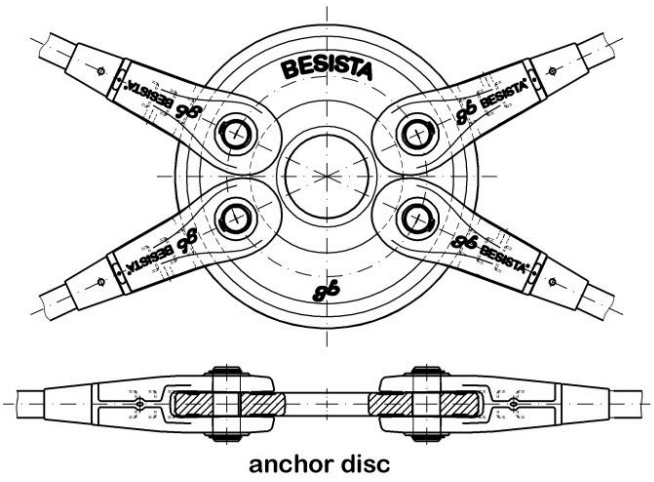
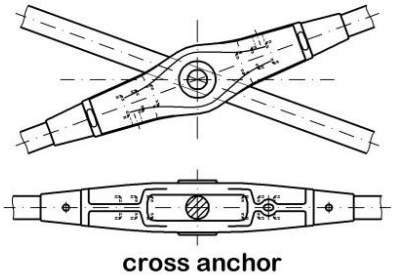
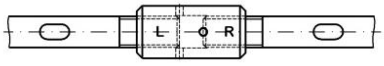
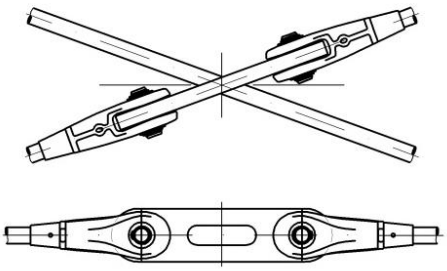


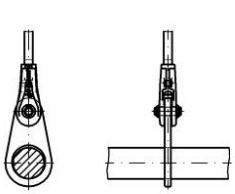


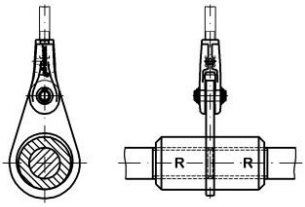


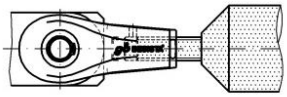


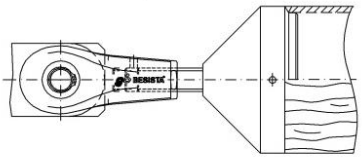


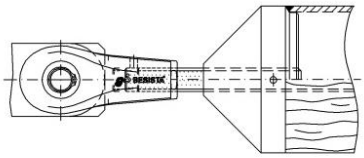












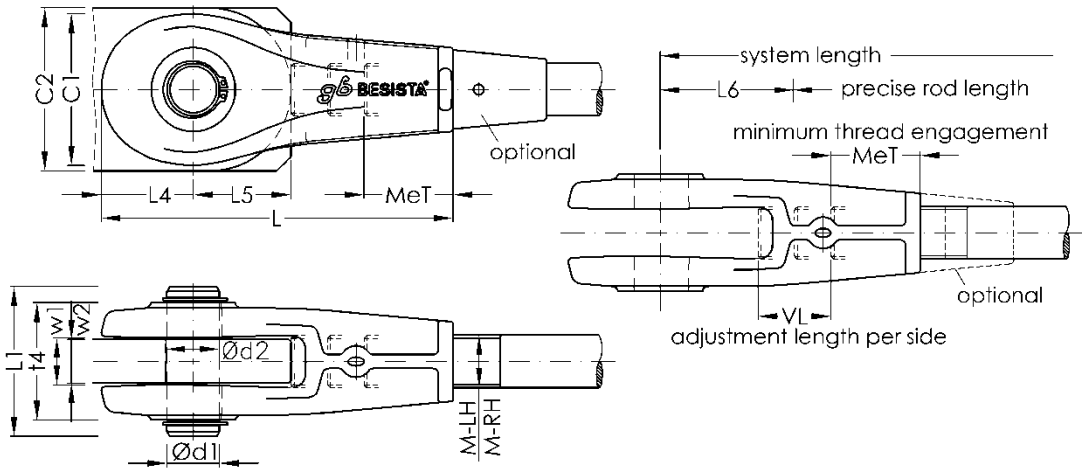
BESISTA 2-540 Tension Rod System	Annex B1
System, components	

System component	Material	Material no.	Technical delivery condition	Yield strength min. R_e / $R_{p\ 0,2}$ [N/mm²]	Tensile strength min. R_m [N/mm²]
Rod anchor, Cross anchor	EN-GJS-400-18-LT	5.3103	EN 1563:2012	250	400
Tension rod	S460N (Ø 6 to Ø 48)	1.8901	EN 10025-3:2005	520	720
	S460N (Ø 52 to Ø 76)	1.8901	EN 10025-3:2005	540	720
	S355J2	1.0577	EN 10025-2:2005	according EN 10025-2:2005	
	S235J2	1.0117	EN 10025-2:2005	according EN 10025-2:2005	
Pin for Tension rods and Compression rods	S460N (Ø 6 to Ø 48)	1.8901	EN 10025-3:2005	520	720
	S460N (Ø 52 to Ø 76)	1.8901	EN 10025-3:2005	540	720
	8.8	-	EN ISO 898-1:2013	according EN ISO 898-1:2013	
	10.9	-	EN ISO 898-1:2013	according EN ISO 898-1:2013	
Gusset plate, anchor disc, Cross plate	EN-GJS-400-18-LT	5.3103	EN 1563:2012	250	400
	S355J2	1.0577	EN 10025-2:2005	according EN 10025-2:2005	
	S235J2	1.0117	EN 10025-2:2005	according EN 10025-2:2005	
Coupler, Turnbuckle	S460N (Ø 6 to Ø 48)	1.8901	EN 10025-3:2005	520	720
	S460N (Ø 52 to Ø 76)	1.8901	EN 10025-3:2005	540	720
	S460N	1.8901	EN 10025-3:2005	according EN 10025-3:2005	
	S355J2H	1.0576	EN 10210-1:2006	355	510
	S355J2	1.0577	EN 10025-2:2005	according EN 10025-2:2005	
	EN-GJS-400-18-LT	5.3103	EN 1563:2012	250	400
Compression rod connections	S355J2	1.0577	EN 10025-2:2005	according EN 10025-2:2005	

BESISTA 2-540 Tension Rod System

Material properties of components

Annex B2

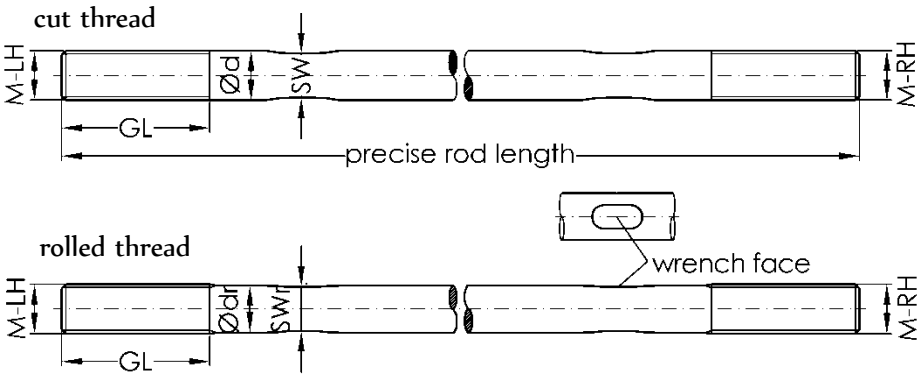


M	rod anchor								pin			gusset plate			
	C1	L4	w1	MeT	t4	L	VL	L6	∅ d1	L1	steel grade	∅ d2	w2	L5	C2
6	18	11	6	10	13.5	45	12	18	6	20	S460N (R_e=520 N/mm², R_m=720 N/mm²), 8.8 or 10.9	6.5	5	12	22
8	24	14.2	7	15.3	19	59.5	14	23	8	29.6		8.5	6	16	28
10	29	17.5	9.2	18	23	71.5	16	28	10	32.3		11	8	20	35
12	35.4	21	11.2	22	27.2	83.5	18	32	12	38.4		13	10	23	41
14	41.2	24.5	13.4	24.5	31.8	96	20	37	14	41.9		15	12	27	47
16	45.6	27.5	16.4	28	38.5	108.5	22	42	16	48.4		17	15	31	52
18	51.6	31.5	16.6	31.5	40.2	122	26	46	18	53.9		19	15	34	57
20	56	35	19.6	35	46.5	135	28	51	20	59.9		21	18	37	62
22	63	38.5	19.6	37.5	50	148	30	57	22	62.9		23	18	42	70
24	69	42	21.8	41	54.5	164	36	63	24	67.8		25	20	45	75
27	78	47	23.8	46	61.4	184	40	71	27	75.1	S460N (R_e = 520 N/mm², R_m = 720 N/mm²)	28	22	51	85
30	86	52.5	27	51	67.6	203.5	44	78	30	82.1		31	25	56	93
33	95	57.5	32.2	56.5	78	220	46	83	33	92.6		34	30	60	99
36	104	63	32.2	61	80.8	241	50	92	36	98.8		37	30	67	112
39	112	68	37.4	66.5	90	259.5	54	98	39	106.8		40	35	71	117
42	121	73.5	37.4	70	95	279.5	58	107	42	115		43	35	78	130
45	129	79	42.8	76	105	301	64	114	45	126		46	40	82	136
48	138	84	42.5	81.5	110	325.5	70	125	48	129		50	40	91	153
52	149	91	47.8	87	120	351	74	137	52	145	S460N (R_e = 540 N/mm², R_m = 720 N/mm²)	54	45	100	167
56	161	99	52.8	93	132	378	80	146	56	158		58	50	106	175
60	173	105	58	99	142	401	84	155	60	168		62	55	113	187
64	184	112	58	106	147	431	92	167	64	175		66	55	122	203
68	196	119.5	63	113	160	457.5	96	177	68	188		70	60	129	214
72	206	126	68	119	168	480	100	185	72	196		74	65	135	224
76	221	134.5	73	126	183	509.5	108	195	76	212		78	70	141	244

BESISTA 2-540 Tension Rod System

Rod anchor, pin, gusset plate

Annex B3



*Note: When using couplers and turnbuckles tension rods have a shorter thread length (GL-VH and GL-SH see Annex B6).

M	GL *	cut threads		rolled threads	
		∅ d	SW	∅ dr	SWr
6	28	6	5	5,3	4,5
8	34	8	7	7,1	6
10	39	10	9	8,9	8
12	45	12	11	10,8	10
14	51	14	13	12,6	11
16	57	16	15	14,5	13
18	65	18	16	16,2	15
20	71	20	18	18,2	16
22	75	22	20	20,2	18
24	87	24	22	22	20
27	96	27	25	25	23
30	107	30	28	27,5	25
33	114	33	30	30,5	28
36	124	36	33	33,2	30
39	133	39	36	36,2	33
42	142	42	39	39	36
45	154	45	42	42	39
48	166	48	45	44,7	42
52	175	52	49	48,7	45
56	189	56	52	52,3	49
60	199	60	56	56,3	52
64	216	64	60	60	56
68	227	68	64	64	60
72	237	72	68	68	64
76	252	76	72	72	68

BESISTA 2-540 Tension Rod System

Tension rod

Annex B4

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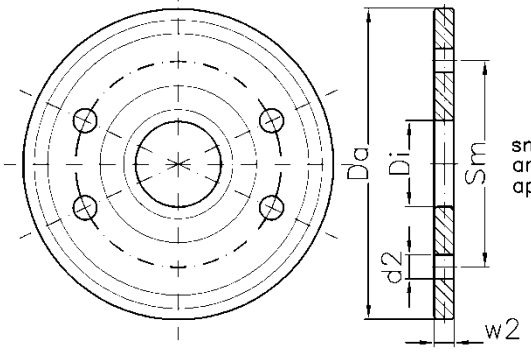
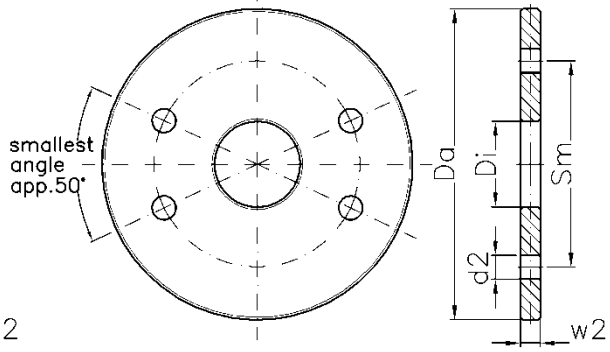
anchor disc made of cast iron



anchor disc made of steel



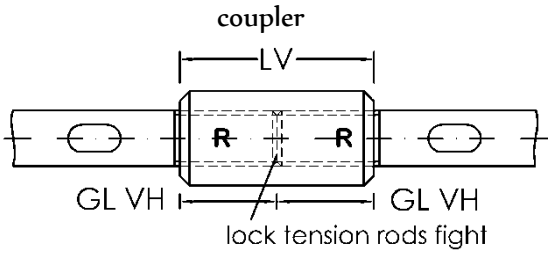
M	Da	Di	Sm	w2	d2
6	73	23	49	5	6.5
8	96	30	64	6	8.5
10	118	36	78	8	11
12	140	42	94	10	13
14	162	48	108	12	15
16	184	54	122	15	17
18	204	60	136	15	19
20	224	66	150	18	21
22	248	72	164	18	23
24	268	78	178	20	25
27	302	88	200	22	28
30	334	98	222	25	31
33	364	108	244	30	34
36	400	118	266	30	37
39	430	128	288	35	40
42	466	138	310	35	43
45	496	148	332	40	46
48	534	158	354	40	50
52	582	170	382	45	54
56	626	184	414	50	58
60	668	196	442	55	62
64	718	210	474	55	66
68	764	226	506	60	70
72	800	234	530	65	74
76	848	248	566	70	78

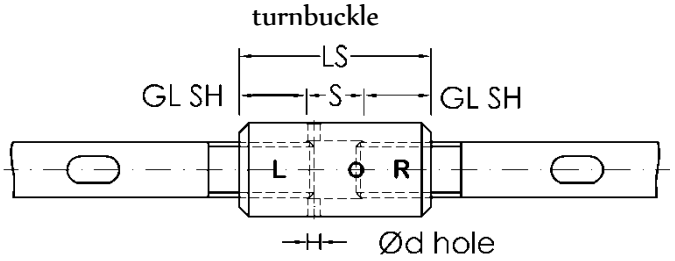
BESISTA 2-540 Tension Rod System

Anchor disc

Annex B5

Deutsches Institut für Bautechnik DIBt





M	coupler (VH)		turnbuckle (SH)			
	GL VH	LV	GL SH	LS	S	∅ d hole
6	10.5	21	7.5	21	6	3
8	14	28	10	28	8	4
10	17.5	35	12.5	35	10	4
12	21	42	15	42	12	5
14	24.5	49	17.5	49	14	5
16	28	56	20	56	16	6
18	31.5	63	22.5	63	18	6
20	35	70	25	70	20	6
22	38.5	77	27.5	77	22	6
24	42	84	30	84	24	8
27	47.5	95	34	95	27	8
30	52.5	105	37.5	105	30	8
33	58	116	41.5	116	33	8
36	63	126	45	126	36	10
39	68.5	137	49	137	39	10
42	73.5	147	52.5	147	42	10
45	79	158	56.5	158	45	10
48	84	168	60	168	48	10
52	91	182	65	182	52	12
56	98	196	70	196	56	12
60	105	210	75	210	60	12
64	112	224	80	224	64	12
68	119	238	85	238	68	15
72	126	252	90	252	72	15
76	133	266	95	266	76	15

BESISTA 2-540 Tension Rod System

Turnbuckle, coupler

Annex B6

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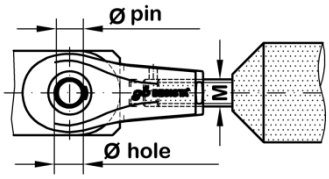
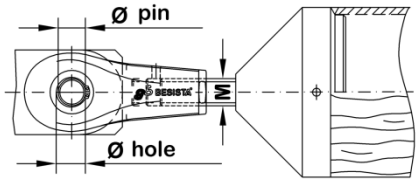
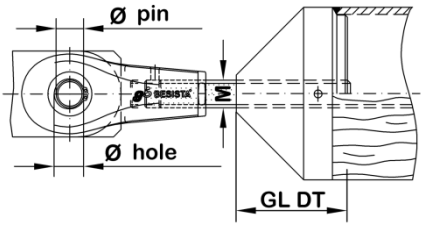
Machined compression rod connection (solid rod)



Compression rod connection one part for tube or timber



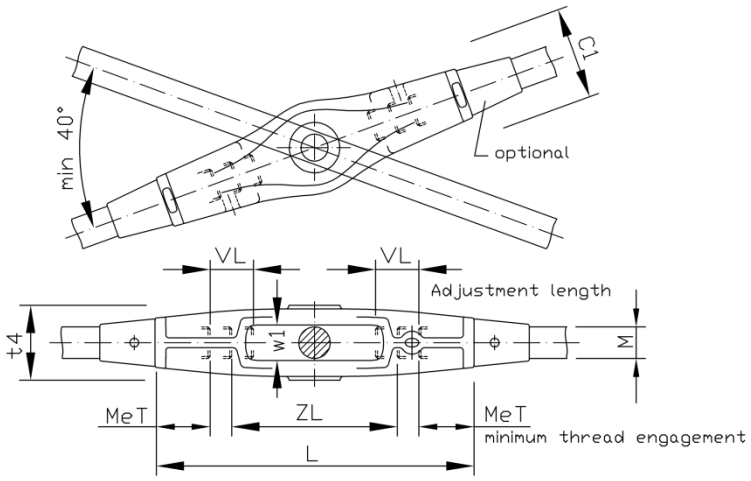
Compression rod connection two-part (tube) with higher-strength threaded bolts



Note: the diameters of the pins for connections to compression bars are larger than the diameters of the pins for connections to tension rods

M	Connection to compression rods		
	∅ pin	∅ hole	GL DT
6	8	8.5	min. 1.20 x M
8	10	10.5	
10	12	13	
12	14	15	
14	16	17	
16	18	19	
18	20	21	
20	22	23	
22	24	25	
24	27	28	
27	30	31	
30	33	34	
33	36	37	
36	39	40	
39	42	43	
42	45	46	
45	48	49	
48	52	54	
52	56	58	
56	60	62	
60	64	66	
64	68	70	
68	72	74	
72	76	78	
76	80	82	

BESISTA 2-540 Tension Rod System	Annex B7
Connection to compression bars	



Any deviations vis-à-vis the rod anchors are offset by the material accumulation at the strap transitions (C1) and the material in the blanked-off „pin holes" (t4).

M	Cross anchor						
	C1	w1	MeT	t4	L	ZL	VL
6	17	6,8	10	13,5	68	36	12
8	23	8,8	15,3	19,5	90	46	14
10	27	11	18	22,6	110	56	16
12	33	13	22	26,9	123	64	18
14	39	15	24,5	31,9	141	74	20
16	42	17,5	28	38,7	160	84	22
18	48	19,5	31,5	41,3	180	94	26
20	53	21,5	35	47,2	202	102	28
22	60	23,5	37,5	49,8	218	114	30
24	66	25,5	41	54,7	243	126	36
27	75	28,5	46	60,3	271	142	40
30	83	32	51	66,7	298	156	44
33	92	35	56,5	77,1	328	166	46
36	101	38	61	81,3	360	184	50
39	109	41	66,5	90	385	196	54
42	117	44	70	96,2	418	214	58
45	125	47,5	76	105	444	228	64
48	133	50,5	81,5	110	483	252	70
52	144	54,5	87	120	520	274	74
56	155	59	93	132	558	292	80
60	167	63	99	142	592	310	84
64	177	67	106	147	638	336	92
68	189	71	113	160	676	354	96
72	198	75	119	168	708	370	100
76	213	79	126	183	750	390	108

BESISTA 2-540 Tension Rod System

Cross anchor

Annex B8

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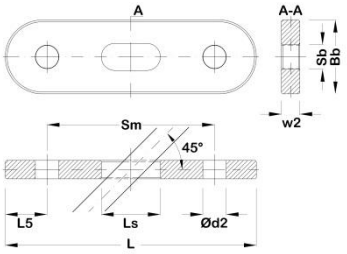
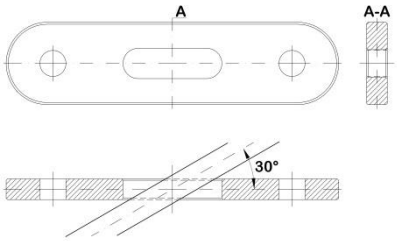
Cross plate 45°



Cross plate 30°



Bb = C2 - Ød2 off Annex B3 + crack (S) + Øtension rod

	A	B	C	D	F	G	H	N	O	P	Q	R	S
	Thread	45°			30°								
		L	Sm	Ls	L	Sm	Ls	Sb	Bb	w2	Ø d2	L5	crack = Bb - Sb
	M												
	8	96	***64***	20	114	***82***	30	10	30	***6***	8,5	***16***	20
	10	118	***76***	25	138	***98***	38	12	36	***8***	11	***20***	24
	12	140	***94***	31	162	***116***	48	14	42	***10***	13	***23***	28
	14	162	***108***	36	190	***136***	56	17	49	***12***	15	***27***	32
	16	184	***122***	45	220	***158***	68	19	54	***15***	17	***31***	35
	18	204	***136***	48	242	***174***	72	21	59	***15***	19	***34***	38
	20	224	***150***	55	270	***196***	84	23	64	***18***	21	***37***	41
	22	248	***164***	59	296	***212***	89	25	72	***18***	23	***42***	47
	24	268	***178***	64	322	***232***	98	28	78	***20***	25	***45***	50
	27	302	***200***	72	362	***260***	108	31	88	***22***	28	***51***	57
	30	334	***222***	78	402	***290***	120	34	96	***25***	31	***56***	62
	33	364	***244***	90	440	***320***	138	37	102	***30***	34	***60***	65
	36	400	***266***	96	480	***346***	146	40	115	***30***	37	***67***	75
	39	430	***288***	100	520	***378***	162	44	121	***35***	40	***71***	77
	42	466	***310***	110	558	***402***	168	47	134	***35***	43	***78***	87
	45	496	***332***	120	602	***438***	186	50	140	***40***	46	***82***	90
	48	534	***352***	124	646	***464***	194	53	156	***40***	50	***91***	103
	52	582	***382***	136	704	***504***	212	57	170	***45***	54	***100***	113
	56	626	***414***	148	760	***548***	232	62	179	***50***	58	***106***	117
	60	668	***442***	160	816	***590***	252	66	191	***55***	62	***113***	125
	64	718	***474***	170	866	***622***	262	70	207	***55***	66	***122***	137
	68	764	***506***	178	928	***670***	280	74	218	***60***	70	***129***	144
	72(73)	800	***530***	190	976	***706***	300	79	229	***65***	74	***135***	150
	76	848	***566***	202	1042	***760***	320	84	250	***70***	78	***141***	166

BESISTA 2-540 Tension Rod System

Cross plates

Annex B9